C. REMARKS/ARGUMENTS

1. Status of the Claims

Claims 1 - 24 are currently pending in the application. Claims 1, 14, 15, 16, 17, 18, 19, 21, and 24 are independent. Claims 2-13 depend on claim 1. Claim 20 depends on claim 19. Claims 22-23 depend on claim 21.

2. Rejection of Claims 1, 2, and 4-8 Under 35 U.S.C. § 103(a)

Claims 1, 2, and 4-8 stand rejected under 35 U.S.C. § 103 as being unpatentable over a IEEE Nuclear Science Symposium and Medical Imaging Conference paper titled "Application of DSP Techniques to Nuclear Magnetic Resonance Spectroscopy" by Worley (henceforth "Worley"), and U.S. Pat. No. 5,041,789 to Keller ("Keller"). Applicant respectfully traverses these rejections.

It is well known that, in order to establish a *prima facie* case of obviousness, a rejection must, *inter alia,* satisfy at least the following: the prior art reference(s) must teach or suggest all of the elements and limitations recited in the claims. MPEP 2142.

Applicant submits that the cited documents Worley and Kelley, either alone or in combination, fail to teach or suggest all of the elements and limitations recited in claims 1, 2, and 4-8.

Claim 1

Applicant's claim 1 is reproduced below:

1. An apparatus for performing spectral analysis, the apparatus comprising:

a. a data acquisition system configured to measure a signal emitted from a sample in response to excitation energy applied thereto, and to average the measured signal over a plurality of measurements to generate an averaged signal;

b. a data processing system including:

a noise-reduction pre-processor configured to create a vector space from said averaged signal, and to generate one or more singular values and corresponding eigenvectors of a correlation matrix constructed within said vector space, said vector

space containing a noisefree signal subspace and a noise subspace, said singular values including noisefree singular values associated with said noisefree signal subspace, and noise singular values associated with said noise subspace; and

c. a control system configured to identify a gap between a noisefree singular value and an adjacent noise singular value, so as to request the data acquisition system to perform additional measurements if no such separation can be identified, and to prevent further measurements from being made by the data acquisition system if the appearance and stability of said gap can be established.

Worley

As acknowledged by the Examiner (see Office Action page 3, line 4 "*Worley does not teach the control system*"), Worley does not disclose any control system configured to identify a gap between a noisefree singular value and an adjacent noise singular value, or to prevent further measurements if the appearance and stability of the gap can be established.

Kelley

Kelley relates to the use of a barcode reader to input into an NMR instrument information relating to specification of measurement sequence. This is completely different from the subject matter recited in Applicant's claims, namely reducing noise in spectroscopy by creating a vector space from an averaged signal, generating singular values of a correlation matrix constructed within the vector space, and identifying a gap between a noisefree singular value and an adjacent noise singular value so as to prevent further measurements from being made if the appearance and stability of the gap can be established. There is no teaching or suggestion anywhere in Kelley of the above-described subject matter, which is recited in Applicant's claims and described in Applicant's disclosure.

The Examiner states: "*Keller teaches a control system in an NMR system that prevents further measurements from being made when a gap is identified or a minimum signal-to-noise ratio (SNR) is reached. (Col. 9, lines 11-37).*" (Office Action page 3, lines 4-7). Applicant disagrees.

Contrary to the Examiner's statement, there is nothing in Col. 9, lines 11-37 about any control system that identifies any gap, much less any gap between a noisefree singular value and an adjacent noise singular value, which is what is required by Applicant's claim 1. Also contrary to the Examiner's statement, there is nothing in Col. 9, lines 11-37 about any control system that prevents further measurements from being made when such a gap is identified.

In contrast, Col. 9 lines 11-37 of Keller, reproduced below, describe different types of information relating to signal excitation and acquisition that is provided by measurement-sequence control programs:

> Among the items of magnetic-resonance signal excitation and acquisition information provided for such a spectrometer by preferred measurement-sequence control programs as the programs are run are: (1) the center frequency of a measurement channel, e.g. the approximate magnetic-resonance frequency of protons, carbon-13, or other types of nuclei in the magnetic field of the magnet of the spectrometer, (2) the frequency of the locking channel, e.g. the particular frequency of the proton, deuterium or other nuclear magnetic resonance line from the particular chemical compound used for locking the magnetic field, (3) the width, the intensity, the phase, and the spacing of the radio-frequency pulses applied to the sample from the measurement channel in each measurement run, e.g. the pulse sequence of the experiment, (4) a flag specifying whether or not a radio-frequency decoupling signal is to the applied to the sample from a decoupling channel, and, if so, the frequency, the power level, and the timing of the decoupling signal, (5) the number of digitized data points to be collected in each measurement run, (6) the time interval between data points, (7) a delay interval between measurement runs, and (8) a flag specifying a termination criterion for the number of measurement runs, e.g. a minimum-signal-to-noise criterion or a fixed-number-of-runs criterion, for which latter criterion the number of runs is also specified.

As seen from the section of Kelley quoted by the Examiner and reproduced above (Col. 9 lines 11-37), nowhere in Kelley Col. 9 lines 11-37, nor anywhere else in Kelley, is there any teaching or suggestion of a control system that identifies any gap between a noisefree singular value (of a correlation matrix constructed within a vector space created from an averaged signal) and an adjacent noise singular value (of that same correlation matrix). Nor is there any teaching or suggestion of any control system that prevents further measurements from being made if the appearance and stability of such a gap can be established, in Col. 9 lines 11-37 of Kelley or elsewhere in Kelley.

Regarding the part of the Examiner's statement that relates to the reaching of a minimum signal-to-noise ratio (SNR), and preventing further measurements when such a minimum SNR is reached, Applicant notes that nowhere in Claim 1 is there any mention or recitation of any minimum signal-to-noise ratio (SNR), nor of any prevention of further measurements from being made when any minimum signal-to-noise ratio is reached. Therefore, the Examiner's statement relating to minimum signal-to-noise ratio is irrelevant for purposes of determining whether Kelley discloses one or more limitations of claim 1.

Applicant further notes that Kelley does not teach or suggest any of the other limitations of claim 1. In particular, Kelley does not teach or suggest a data acquisition system configured to average a signal, emitted from a sample in response to excitation energy applied thereto, over a plurality of measurements to generate an averaged signal. Nor does Kelley teach or suggest any data processing system that includes a noise-reduction pre-processor configured to create a vector space from the averaged signal and to generate singular values and eigenvectors of a correlation matrix constructed within the vector space, or a control system configured to identify a gap between a noisefree singular value and an adjacent noise singular value so as to request the data acquisition system to perform additional measurements if no such separation can be identified, or a control system configured to prevent further measurements from being made by the data acquisition system if the appearance and stability of the gap can be established.

Combination of Worley and Kelley

In sum, the Examiner has acknowledged that Worley fails to teach at least the limitation in claim 1 that requires a control system configured to identify a gap between a noisefree singular value and an adjacent noise singular value, to request additional measurements to be performed if no such separation can be identified, and to prevent further measurements from being made if the appearance and stability of the gap can be established.

Kelley fails to cure such a deficiency of Worley, because Kelley fails to teach or suggest such a control system, as explained in detail above, and also fails to teach or suggest a number of other limitations of claim 1, as described above.

Accordingly, the proposed combination of Worley and Kelley is not a proper basis for an obviousness of rejection of claim 1, since the proposed combination of Worley and Kelley does not teach all the elements of claim 1.

Claims 2 and 4-8

It is well known that "[i]f an independent claim is nonobvious under 35 U.S.C. § 103, then any claim depending therefrom is nonobvious." MPEP 2143.03; In re Fine, 837 F.2d 1071, 2 USPQ2d 1596 (Fed. Cir. 1988).

Claims 2 and 4-8 depend on claim 1, and therefore include all the limitations of claim 1. For all the reasons discussed above, claim 1 is not obvious under 35 U.S.C. § 103 over Worley and Kelley. It follows that claims 2 and 4-8 (all depending from claim 1) are also not obvious under 35 U.S.C. §103.

3. Rejection of Claims 9-13 Under 35 U.S.C. § 103(a)

Claims 9-13 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Worley and Keller, as applied to claims 1, 2, and 4-8 above, and further in view of U.S. Patent Application Publication No. 2004/0054479 to Trickett et al. (henceforth "Trickett").

For all the reasons set forth in section 2 above, claim 1 is not obvious under 35 U.S.C. § 103 over Worley and Keller, as discussed in detail above.

Claims 9-13 depend on claim 1, and therefore include all the limitations of claim 1. It follows that claims 9-13 (all depending from claim 1) also are not obvious under 35 U.S.C. §103 over Worley and Kelley.

As for Trickett, in addition, Trickett teaches noise reduction in seismic data (see e.g. Trickett paragraph [0001] "*The present invention relates generally to processing*

seismic data and particularly to reducing noise in seismic data using a variety of 3D eigen filtering techniques based on matrix rank reduction in the frequency domain"). Trickett does not teach or suggest, or relate to, any of the limitations of claim 1. The Examiner also does not state anywhere in the Office Action that Trickett teaches any of the limitations of claim 1.

As explained above, the combination of Worley and Kelley fails to teach at least the limitation of claim 1 relating to a control system configured to identify a gap between a noisefree singular value and an adjacent noise singular value, and to prevent further measurements from being made if the appearance and stability of the gap can be established.

Since Trickett does not teach any of the limitations of claim 1, the combination of Worley, Kelley, and Trickett also fails to teach or suggest at least the above limitation of claim 1 relating to the control system.

Claims 9-13 depend on claim 1, and include all the limitations of claim 1, and therefore are not obvious under 35 U.S.C. § 103 over the combination of Worley, Kelley, and Trickett.

Applicant further submits that not only does Trickett fail to disclose all of the elements of independent claim 1 (from which claims 9-13 depend), but also Trickett fails to disclose additional limitations that are recited in dependent claims 9-13.

Regarding Trickett, the Examiner states as follows:

"*The application of Trickett teaches a method of noise reduction using matrix rank reduction. Trickett does not teach a system that uses averaged signals, however Worley et al. specifically teaches that averaged NMR transients are used as an input to the system. It is inherent that the decimated data points have a smaller signal length and a sampling period greater than the input sampling frequency. It would have been obvious to one of ordinary skill in the art to combine these teachings, in order to reduce the amount of time involved in processing the data (Trickett, paragraph 17, lines 3-6).*" Office Action, page 6.

Applicant submits that Trickett, which as acknowledged by the Examiner teaches noise reduction using matrix rank reduction, does not teach or suggest a windowing subsystem configured to apply a windowing filter to a Fourier transform of the averaged signal so as to generate decimated signals having a limited bandwidth, as recited in claim 9, nor does Trickett teach or suggest storing the inverse Fourier transform of each decimated signal as a set of decimated data points, as recited in claim 10, nor does Trickett teach or suggest storing M-dimensional vectors in a form given by $c_n^d = (c_n^d, c_{n+1}^d, \ldots, c_{n+M-1}^d)$, where c_n^d represent the decimated data points, as recited in claim 11, nor does Trickett teach or suggest forming the correlation matrix from the M-dimensional vectors, as recited in claim 12, nor does Trickett teach or suggest projecting the averaged signal based on a projection formula given by $\vec{c}_n^{nr} = \sum_{k=1}^{K} (\vec{u}_k^*, \vec{c}_n)\vec{u}_k$, as recited in claim 13. Trickett thus fails to disclose the additional limitations (set forth above) that are recited in dependent claims 9-13.

For all of these reasons, Applicant submits that claims 9-13 are allowable, and not obvious under 35 U.S.C. § 103(a) over Worley, Kelley and Trickett.

4. Rejection of Claims 3, and 14-24 Under 35 U.S.C. § 103(a)

Claims 3 and 14-24 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Worley and Keller, as applied to claim 1, and further in view of U.S. Pat. No. 5,453,940 to Broomhead (henceforth "Broomhead") and U.S. Pat. No. 5,148,522 to Okazaki (henceforth "Okazaki"). Applicant respectfully traverses these rejections.

Claim 3

Claim 3, depends on claim 1 and includes all of the limitations of claim 1, and therefore is not obvious under 35 U.S.C. § 103(a) over Worley and Keller, for reasons set forth in section 2 above.

Both Broomhead and Okazaki fail to cure this deficiency of Worley and Keller.

Regarding Broomhead, Broomhead relates to an analyzer for dynamical systems, not to an apparatus for performing spectral analysis as required by independent claim 1 (upon which claim 3 depends). Broomhead does not teach or suggest any of the limitations of claim 1.

In particular, Broomhead relates to analyzing dynamic systems that may be mathematically nonlinear or chaotic, by creating a mathematical model used to predict future behavior of a dynamical system on the basis of preceding behavior of the system. (See e.g. Broomhead col. 1, lines 6-9, and col. 2, lines 12 - 18: "*This invention relates to a dynamical system analyser, and more particularly to such a device applicable to analysis of dynamical systems which might be nonlinear or chaotic in the mathematical sense. . . . The invention . . . produces a mathematical model of a dynamical system. . . .*) Broomhead is unrelated to the subject matter of Applicant's claims or specification, namely noise reduction in an apparatus for spectral analysis

As acknowledged by the Examiner, Broomhead teaches a processing system that performs singular value decomposition of time series signals from a non-linear dynamical system. (See e.g. Broomhead col. 2, lines 22 – 32: "*. . . the invention provides a dynamical system analyser including: (1) means for deriving a time series of signals from a dynamical system, (2) means for generating from the time series a set of singular vectors . . . corresponding to a subset of a set of vectors from a singular value decomposition of the time series . . .* ").

Applicant notes, however, that a time series of signals from a non-linear dynamical system, or a singular value decomposition thereof, is not recited in any of Applicant's claims. Therefore, the teaching by Broomhead of a singular value decomposition of a time series of signals from a dynamical system is irrelevant for purpose of determining whether any limitation(s) of Applicant's claims are taught in Broomhead.

Applicant submits that none of the limitations of claim 1 is taught or suggested by Broomhead. In particular, Broomhead does not teach or suggest an apparatus for performing spectral analysis, nor a data acquisition system configured to measure a

signal emitted from a sample in response to excitation energy applied thereto and to average the signal over a plurality of measurements to generate an averaged signal, nor a noise-reduction pre-processor configured to create a vector space from the averaged signal, the vector space containing a noisefree signal subspace and a noise subspace, and to generate singular values of a correlation matrix constructed within the vector space, the singular values including noisefree singular values associated with the noisefree signal subspace, and noise singular values associated with the noise subspace.

Nor does Broomhead teach or suggest a control system configured to identify a gap between a noisefree singular value and an adjacent noise singular value so as to request the data acquisition system to perform additional measurements if no such separation can be identified, and to prevent further measurements from being made by the data acquisition system if the appearance and stability of the gap can be established.

Regarding Okazaki, Okazaki is directed to an information retrieval apparatus, and is not relevant to claim 3, because Okazaki does not teach or suggest any element of claim 3. In particular, Okazaki does not teach or suggest any pattern recognition system adapted to identify a gap between a noisefree singular value and an adjacent noise singular value, in a plot of singular values, as required by claim 3.

Furthermore, Okazaki, relates to "*an information retrieval apparatus*" and "*an information retrieval interface for handling requests for retrieving two-dimensional information*" (see e.g. Okazaki Col. 1, lines 15-20), and is wholly unrelated to any apparatus for performing spectral analysis, contrary to Applicant's does not teach or suggest any element of any of Applicant's claims. The Examiner also acknowledged that Okazaki teaches a system for retrieving two-dimensional information.

The Examiner states: "*. . . Okazaki teaches that the system can be configured to recognize retrieval conditions (col. 2, lines 7-18).*" Office Action page 8. Applicant notes that "recognizing retrieval conditions" is not recited in any of Applicant's claims,

including claim 3, and therefore that this statement by the Examiner is irrelevant in analyzing Applicant's claims, including claim 3.

The Examiner further states: "*It would have been obvious to one of ordinary skill in the art to combine these teachings of Worley, Kelley, Broomhead, and Okazaki for the purpose of creating a more user-friendly system. These systems when combined would shorten the length of time needed to acquire signals of interest.*" Office Action page 8. Applicant notes that neither "*creating a more user-friendly system*" nor "*shortening the length of time needed to acquire signals of interest*" are recited in Applicant's claim 3. Therefore, this statement by the Examiner is irrelevant in analyzing claim 3, the limitations of which are not taught by the proposed combination of Worley, Kelley, Broomhead, and Okazaki.

In sum, neither Broomhead nor Okazaki teach any of the limitations of claim 3.

For all of these reasons, Applicant submits that the combination of Worley, Keller, Broomhead and Okazaki fails to disclose all of the elements of independent claim 1 (from which claim 3 depends), as well as failing to disclose the additional limitations recited in dependent claim 3. Applicant therefore submits that claim 3 is allowable, and not obvious under 35 U.S.C. § 103(a) over Worley, Keller, Broomhead, and Okazaki.

Claims 14- 19, 21, and 24

The Examiner states:

"*Regarding independent claims 14-19, 21, and 24, see the rejections of claims 1-5. The combination of Worley, Keller, Broomhead, and Okazaki teaches these features.*" Applicant disagrees.

For reasons explained above, the combination of Worley, Keller, Broomhead, and Okazaki fails to teach or suggest at least the following limitations of claims 14-19, 21, and 24: elements a and b of claim 14; element a of claim 15; element c of claim 16; elements b, c, d, and e of claim 17; elements b, c, d of claim 18, elements c, d, e of claim 19, elements a, b, c, and d of claim 21, and elements f, g, h, i, and j of claim 24.

For all of these reasons, Applicant submits that claims 14-19, 21, and 24 are allowable, and not obvious under 35 U.S.C. § 103(a) over Worley, Keller, Broomhead, and Okazaki.

Claims 20, 22, 23

It is well known that "[i]f an independent claim is nonobvious under 35 U.S.C. § 103, then any claim depending therefrom is nonobvious." MPEP 2143.03; In re Fine, 837 F.2d 1071, 2 USPQ2d 1596 (Fed. Cir. 1988).

Claim 20 depends on claim 19, and therefore includes all the limitations of claim 19. Claims 22 and 23 depend on claim 21, and therefore include all the limitations of claim 21. For all the reasons discussed above, claims 19 and 21 are not obvious under 35 U.S.C. § 103 over Worley, Keller, Broomhead, and Okazaki.. It follows that claim 20 (depending from claim 19) and claims 22-23 (depending from claim 21) are also not obvious under 35 U.S.C. §103.

5. Conclusion

On the basis of the foregoing amendments, Applicant respectfully submits that all of the pending claims 1-24 are in condition for allowance. An early and favorable action is therefore earnestly solicited.

Respectfully submitted,

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